FULLY 3D CONTINUUM AND COMPUTATIONAL FORMULATIONS FOR STRESS-MODULATED SOFT TISSUE GROWTH

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Growth is fundamental biomechanical process both in normal development of tissues and in a number of pathological conditions. It is known for years that mechanical factors such as stress and strain can modulate tissue growth, and growth of a tissue can, in turn, alter the stress state. Indeed, the interaction between growth and mechanical environment is an essential characteristic of tissue mechanics. In recent years, theories of stress-modulated growth have been proposed and employed in the biomechanical analysis living organisms, in particular in cardiovascular systems [1, 2].

This contribution concerns the development of a computational framework for the finite element analysis of boundary value problems involving adaptive tissue growth. The formulation is based on plasticity-like theories, the constitutive equations of which consist of a strain energy function relative to the local natural configuration, and time-rate equations relating the rate of growth variables to stress. Both isotropic and anisotropic models are considered. The key computational implication is the development of implicit integration schemes for the rate equation of the growth variables. An an example of application, the formulation is employed to perform 3D analysis of the growth of human abdominal aortic aneurysms.

References

[1] E.K. Rodriguez, A. Hoger, and A.D. McCulloch. Stress-dependent finite growth in soft elastic tissues. *Journal of Biomechanics*, 27:455–467, 1994.

[2] L.A. Taber. Biomechanics of cardiovascular development. *Annual Review of Biomedical Engineering*, 3:1–25, 2001.